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## FOSSIL PLUMAGE.

C. R. EASTMAN.

PRESERVATION of avian remains in the fossil state is necessarily of very rare occurrence, and extraordinarily so, if fossilization takes place in marine sediments. Cases of the latter description presuppose the creature either to have perished at sea, or to have been swept out at a distance from the land as a floating carcass without having been destroyed by predaceous animals. The body must have sunk to the bottom before decomposition had advanced far enough to disrupt the skeleton and scatter the plumage. Burial by fine sediments must have followed almost immediately, in order that the body be preserved intact. And mineral replacement of the organic tissues must have proceeded in a wonderfully subtle manner, transforming the most delicate particles into stone without obliterating their microscopic structure.

Supposing a dead bird to have reached the bottom in a tolerably complete condition, the feathers naturally become loosened and scattered with decomposition of the skin, and the least current is liable to sweep them away except they become entangled and covered by the sediment at once. If the material happens to be a fine calcareous ooze, the feathers may leave in it an exceedingly delicate impression, or, in the rarest cases of all, their structure may become replaced molecule for molecule by mineral matter, generally calcareous or carbonaceous.

Chance, controlling thus absolutely the fate of this class of remains, goes away after sealing them up in the rocks to remain hidden for ages; but may peradventure come back again, and disclosing them to the light of day, permit them to fall into the domain of scientific investigation. Great as is the miracle, it has actually happened a few times, as witness the two complete individuals of *Archæopteryx* that are known, and one of *Hesperornis*, with their plumage preserved. Scarcely less

interesting and remarkable are the complete examples found in lacustrine and fluviatile deposits, the most perfect in our own country being *Palæospiza* from the insect-bearing shales of Florissant, Colorado, and *Gallinuloides* from the Green River Eocene of Wyoming. In the former the plumage is preserved, in the latter it is wanting.<sup>1</sup> Skeletons nearly as perfect as these have also been described from fresh-water deposits of the south of France and elsewhere in Europe.

But it is fossil plumage from marine deposits with which this article is especially concerned. The feathers of *Archæopteryx* are too well known to require more than a mere mention of their occurrence, and those of *Hesperornis*, recently made known from the Kansas Cretaceous, are still fresh in the minds of students.<sup>2</sup> There is yet another marine horizon from which feathers have been obtained, these constituting, however, the only indication of avian life which exists in the formation. This is the Upper Eocene limestone of Monte Bolca in the Veronese, famous for nearly four centuries on account of its remarkable fish and plant remains. But as for the occurrence of detached feathers to the exclusion of other remains, it should be remembered that marine and shore-birds are constantly shedding them, and hence, if circumstances favoring preservation are equal, they are likely to be numerically more abundant than bones.

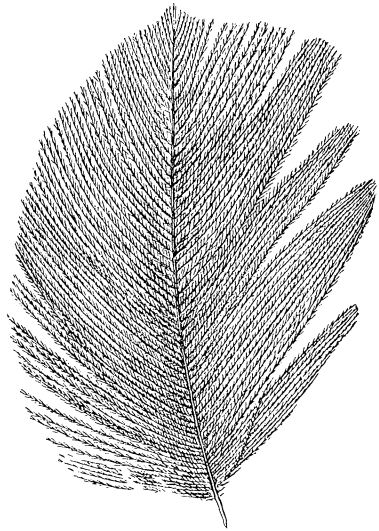
Owing to their excessive rarity and wonderful preservation, it is not surprising that the few feathers thus far obtained from Monte Bolca should be objects of considerable interest. In the early days of palæontology, no little rivalry was created over the acquisition of the first specimens brought to light, one having been found in 1777, and another some twenty years later, both

<sup>1</sup> A solitary feather from the Green River shales of Wyoming was discovered by F. V. Hayden in 1869, and noticed by Marsh in the *American Journal of Science* for 1870 (vol. 49, p. 272). Detached feathers are also known from the Florissant locality in Colorado; the Lower Miocene of Ronzon, near Puy-en-Veday; the Upper Miocene lignite of Rott, near Bonn; and from the Upper Miocene lacustrine deposits of Oeningen, Switzerland. Good examples from the last-named locality, and of Ratite feathers from the Quaternary of New Zealand, are preserved in the Museum of Comparative Zoölogy at Cambridge.

<sup>2</sup> Williston, S. W., *Kansas Univ. Quar.* Vol. 5, p. 53, 1896. — Marsh, O. C., *Amer. Journ. Sci.* [4] vol. 3, p. 347, 1897.

being in counterpart. These two specimens, which are now preserved in the Paris Museum of Natural History, were described and figured in the early part of the last century by Faujas-St.-Fond,<sup>1</sup> but not without misgivings lest his readers be inclined to doubt their avian nature. The names are given of four professors at the Museum who agree with the author in his conclusions, and it is observed that with reference to one of the feathers, that “on ne sauroit la confondre avec certains *fucus* qui ont quelques rapports apparens avec des plumes, parce que celle-ci a ses barbes garnies d'autres petites barbes.” This is the only statement which is given in regard to the finer structure, and the latter is not illustrated in the figures. Both of these feathers, it may be added, are of the pennaceous, and not of the plumaceous variety.

Except for a casual mention by Milne Edwards<sup>2</sup> of his having seen one or two fossil feathers in Verona, where they are still on exhibition in the Public Museum, no other references occur in literature to this sort of remains from Monte Bolca. It may therefore be of interest to examine the figure which is given herewith of a specimen recently acquired by the Museum of Comparative Zoölogy at Cambridge, along with a fine suite of fish-remains from a famous old Veronese collection. This is a small contour feather, only 1.5 cm. long, but remarkable for its perfect preservation of details.



Fossil Carinate feather from the Upper Eocene of Monte Bolca, Italy.  $\times \frac{1}{3}$ .

It is possible to distinguish each separate barb of the symmetrical vane, and even the barbules along either side of the branches.

<sup>1</sup>Faujas-Saint-Fond, B. Mémoire sur quelques fossiles rares de Vestena Nova dans le Véronais. *Ann. Mus. d'Hist. Nat.* vol. 3, pp. 18-24, 1804.

<sup>2</sup>Milne Edwards, A. *Oiseaux Fossiles de la France*, vol. II., p. 544, 1871.

The barbules appear relatively shorter, coarser, and less closely spaced than those in the body-feathers of recent Carinates, and the apex of the vexillum is more pointed. The shaft not being prolonged at the base, it is probable that the specimen is complete in itself, and not the tip of a larger feather. No inferences are warranted regarding even the remote affinities of the form it belonged to, beyond that chances favor its having been a shore bird of small or moderate size. Although the beds were undoubtedly laid down under deep-water conditions, the presence in them of crocodilians, chelonians, and plant remains indicates that the Bolca locality was not far removed from land at the time these strata were deposited. It deserves to be stated that, according to Walther, the Solnhofen lithographic stone in which *Archæopteryx* occurs was deposited within a coral island lagoon.